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WARGAMES & THE SCIENTIFIC METHOD

by

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Biography

Lieutenant Colonel Eric M. Murphy is assigned to the Air War College, Air University, Maxwell AFB, AL. Lieutenant Colonel Murphy was commissioned into the Air Force in 1997 as a graduate of Officer Training School at Maxwell Air Force Base, Alabama. In addition to leading analytic efforts providing force structure insight to senior leaders on the Air Staff Joint Staff, he has served as an Assistant Professor of Mathematics at the United States Air Force Academy and as an operational test director with the Air Force Operational test and Evaluation Center at Kirtland Air Force Base, New Mexico. Lieutenant Colonel Murphy has also served at the Chief of Strategic Planning for Headquarters Air Force Space Command at Peterson Air Force base, Colorado, and as Commander of Air Education and Training Command's Studies and Analysis Squadron. He has also led analytic and strategic planning teams while deployed in support of Operations Enduring and Iraqi Freedom and the International Security Assistance Force mission in Afghanistan. Lieutenant Colonel Murphy holds a Bachelor of Arts in English Literature and a Master of Arts in Mathematics from Eastern New Mexico University, a Master of Philosophy in Military Strategy from the School of Advanced Air and Space Studies at Air University, and a Doctorate in Mathematics from Texas Tech University.

Abstract

Wargames have a long history of use as tools for training and educating decision makers and illuminating the strategic problems of war and warfare. Recent calls for re-invigoration of wargaming culture in the Department of Defense suggest some value in a return to first principles, asking and answering the question what use wargames have. This discussion verifies the commonly-held notions that wargames are useful for training, education, and exploratory analysis or hypothesis generation. It also argues the common belief that wargames are unsuitable for the purpose of hypothesis testing is false.



Introduction

Wargames have a long and distinguished history in illuminating problems of war and warfare. From variations on the ancient game of chess that incorporate warfare phenomena such as Sun Tzu's injunctions on the difficulties of waging war far from home to the structure of ancient Indian armies,¹ and from the German *Koenigspiel*² on the seventeenth century to the *Wermacht's* abstract version of blitzkrieg, known as *Wehrschach* or Tak-Tik,³ simplified games abstracting some aspect of war and allowing players to compete and learn without the spilling of blood. These exceedingly simple (or occasionally not-so-simple) games would grow into the *Kriegspiel* of Lieutenant George Heinrich Rudolph Johann von Reisswitz, praised by General von Muffling, Chief of the German General Staff, with the ejaculation, "This is not a game! This is training for war! I must recommend it to the whole army."⁴ These games grew into the games at the United States Naval War College that led Admiral Chester Nimitz, with only a degree of hyperbole, to remark that nothing had happened in the Second World War's Pacific Theater that was a surprise except for the advent of *kamikazes* late in the war.⁵ These games grew into an industry built on wargames for hobbyists and produced the 1983 board game "Gulf Strike," a game played over and over by analysts at Booz Allen in August 1990, at the request of Andy Marshall from the Pentagon's Office of Net Assessment, to help shed light on what might happen in the weeks and months following Iraq's invasion of Kuwait.⁶

Facing a future marked by rapid technological change, and constrained defense spending and in the context of a complex, dynamic competitive environment, Deputy Secretary of Defense Robert Work and General Paul Selva, Vice Chairman of the Joint Chief of Staff, have called for a re-invigoration of the wargaming culture in the Department of Defense, claiming, "Innovation thrives in a culture that embraces experimentation and tolerates—better yet, encourages—dissent

an risk-taking. We must create an environment in the Department of Defense that encourages exactly this type of thinking. Building a reinvigorated wargaming enterprise is a major step toward that goal.”⁷ And perhaps this call for a reinvigorated culture of wargaming is already bearing fruit.⁸

If the Department is embarked on a major effort to expand the presence and influence of wargames, however, it seems wise to revisit the first principles of these endeavors and ask, What are wargames good for? In the process, we see that wargames serve legitimate and valuable purposes in the training and education of military personnel and civilian decision makers, and play a valuable role in exploratory analysis. More controversially, however, it is also possible for wargames to provide data of use in the testing of theories and hypotheses, advancing the understanding of the strategic choices available and their potential advantages and disadvantages. This is not to say that wargames can be universally, or even generally, applied as single-point sources of truth, not so much because wargames are especially unsuited to such, but rather because such solutions are unlikely to exist.

Thesis

This research paper argues that wargames have value for the education and training of military personnel and civilian decision makers and an important place in the process of inquiry generating and testing hypotheses to create improved theoretical and empirical understanding of war and warfare.



Wargames, Science, and Digital Simulation

On Definitions

Confucius observed with great wisdom that “if names be not correct, language is not in accordance with the truth of things. If language be not in accordance with the truth of things, affairs cannot be carried on to success.”⁹ In beginning any analysis of wargames, therefore, it is imperative to come to a clear understanding of what is meant by the term. The warning of Edward Bruce Hamly in his classic work on *The Operations of War* is worth recalling: “And when in this way plain terms are transmuted into elaborate definitions no use can be made of them. It is a method which, in exchange for a good shilling, gives you a pocketful of bad halfpence.”¹⁰ But Hamly is no advocate of simplicity for its own sake, and cautions against the urge to oversimplify,¹¹ echoing the perhaps more famous injunction of Albert Einstein to keep theory as simple as possible, but no simpler: “It can scarcely be denied that the supreme goal of all theory is to make the irreducible basic elements as simple and as few as possible without having to surrender the adequate representation of a single datum of experience.”¹² What his means for a definition is that it is sufficiently broad to include a class of phenomena that interest, yet not so broad as to include in its purview too many or too widely disparate a collection of phenomena. So what is a wargame?

It seems appropriate to begin with the components of this compound word: war and game. War has been usefully defined in a variety of ways, but one could do worse than to begin with Clausewitz, who wrote: “War is nothing but a duel on a larger scale... War is thus an act of force to compel our enemy to do our will.”¹³ He goes on to expand on this definition in a manner of particular use to the question of what a wargame might be, stating “that war is not merely an act of policy but a true political instrument, a continuation of political intercourse, carried on

with other means. What remains peculiar to war is simply the peculiar nature of its means.”¹⁴ A game, on the other hand is “a competitive activity or sport in which players contend with each other according to a set of rules.”¹⁵ So, there are two critical factors that separate games (and wargames) from war., a separation cogently and concisely summarized by Martin Van Creveld:

“First, whereas war only makes sense to the extent that it is a continuation of politics, the very existence of games depends on that not being the case. Games, in other words, even those that incorporate political factors possess a certain kind of autonomy that war does not have and cannot have. Second, games differ from war in that they are subject to certain highly artificial limits: such as those that govern the location in which they may be held, the way in which they may be played, and, above all, the time they may last and/or the conditions under which they must come to an end... Fundamentally, the restrictions can take two forms. The first consists of pretense, i.e., some way of signaling that the encounter is ‘unreal.’ ... The second is a set of formal, often written rules.”¹⁶

From these qualifications, Van Creveld deduces from a definition for a wargame as a game of strategy, or “the art of seeking to achieve your objectives in the face of an opponent who thinks and acts,” that simulates some key aspect of war.¹⁷

This definition contains three critical elements of war, game, and simulation: war is the field under study via a strategic game whose connection to war is mediated through a simulation. This last qualification, the simulated or approximate nature of the model used to study war, is vital and will be discussed in greater length later, but for now it suffices as a point of leverage to unpack a flaw in Van Creveld’s definition. Through setting the constraints on the approximation as wide as it does—encompassing any activity that walks back from war as a wargame—it violates the second constraint on the desiderata given for a definition. That is, it results in a concept of wargames too broad for analytic utility; it implicitly encompasses phenomena ranging from mock combats to re-enactments, from gladiatorial games to trials by combat, and duels to military training exercises.¹⁸ Peter Perla, in his classic work on wargames, provides a similar definition with an important qualification, suggesting “a wargame is a warfare model or

simulation whose operation does not involve the activities of actual military forces, and whose sequence of events affects and is, in turn, affected by, the decisions made by players representing the opposing sides.”¹⁹ This definition effectively circumscribes the phenomena considered under the rubric of wargame, and has the advantage of relatively broad acceptance.²⁰

Wargames: What Are They Good For?

These two-sided, competitive simulations of war have any number of potential purposes. In *Little Wars*, published shortly before World War I and with a sentiment that would be made more trenchant when that conflict developed into the conflagration it did, H.G. Wells wrote:

How much better is the amiable miniature than the Real Thing! Here is a homeopathic remedy for the imaginative strategist. Here is the premeditation, the thrill, the strain of accumulating victory or disaster—and no sanguinary bodies, no shattering of fine buildings, no devastated country sides, no petty cruelties, none of the awful universal boredom and embitterment, that tiresome delay or stoppage or embarrassment of every gracious, bold, sweet, and charming thing, that we who are old enough to remember a real modern war know to be the reality of belligerence.²¹

So, according to Wells, the notion of play, enjoyment, and thrill in a *wargame* is a real purpose, and an important one.²² But this is not all. Peter Perla suggests that “by involving the player as an active participant in the events, not merely as a passive observer, wargaming provides a unique learning experience that leads to a deeper and more personal understanding and appreciation of war than can be obtained by any method short of actual participation on the field of battle.”²³

Robert Rubel has also observed that the learning here is unavoidable. He notes, “The purpose of the game is immaterial to this central epistemological element. Moreover, the gaining of knowledge is inherent and unavoidable, whatever the game’s object. The real question is whether such knowledge is valid and useful.”²⁴

This raises an instrumental question, however: what is learned in playing such a game and what comprises utility and validity? RAND offers an answer to the first, suggesting wargames “are used to examine warfighting concepts, train and educate commanders and analysts, explore scenarios, and assess how force planning and posture choices affect campaign outcomes.”²⁵ This is helpful, of course, and while but the categories proffered usefully articulate some of the arenas in which questions might be asked and answered, a more useful typology in one that discriminates instead on the intellectual efforts involved and the intended pedagogical audiences, offering leverage on both the question of what is learned and the utility and validity of that learning. For those games in which the pedagogical audience is the participants, games can train or games can educate, and admittedly nuanced distinction that will be made clear below. For those games in which the pedagogical audience is the community creating and administering games in a scientific sense, wargames can either facilitate the development of hypotheses or the testing of hypotheses. Each of these categories places different constraints and restraints on the games themselves, limitations that operate in parallel across the division of audience.

The first purpose of a wargame may be to train participants, to make them “To make proficient with specialized instruction and practice” in a particular aspect of war or warfare.²⁶ And, as Wells and Perla suggest, the play of a game can lead to a deeper and more personal understanding of a situation.²⁷ But this activity suggests there is an answer or mode of behavior in response to given stimuli known to be correct, at the very least in the probabilistic sense that given answers/responses are better on average or with some well-understood or accepted relative frequency. That is, there is a presumption of validity in the cause-and effect relationships embodied in the game, a concept usefully defined in the context of computer simulation as “substantiation that a computerized model within its domain of applicability possesses a

satisfactory range of accuracy consistent with the intended application of the model.”²⁸ The notion that the range of accuracy is satisfactory, rather than perfect, is important. As a model or simulation, a wargame is an approximation of reality and not an emulation of reality. As such, it should include the factors relevant to the intended application with sufficient fidelity to enable the necessary training objectives. George Box, one of the developers of much of our modern understanding of statistical methods, summarizes this need for parsimony in the service of economy aptly.

Since all models are wrong the scientist cannot obtain a 'correct' one by excessive elaboration. On the contrary following William of Occam he should seek an economical description of natural phenomena. Just as the ability to devise simple but evocative models is the signature of the great scientist so over-elaboration and over-parameterization is often the mark of mediocrity.²⁹

A more artful example comes from Jorge Luis Borges, who wrote of an empire in which:

... the Art of Cartography attained such Perfection that the map of a single Province occupied the entirety of a City, and the map of the Empire, the entirety of a Province. In time, those Unconscionable Maps no longer satisfied, and the Cartographers Guilds struck a Map of the Empire whose size was that of the Empire, and which coincided point for point with it. The following Generations, who were not so fond of the Study of Cartography as their Forebears had been, saw that that vast map was Useless, and not without some Pitilessness was it, that they delivered it up to the Inclemencies of Sun and Winters. In the Deserts of the West, still today, there are Tattered Ruins of that Map, inhabited by Animals and Beggars; in all the Land there is no other Relic of the Disciplines of Geography.³⁰

Such a map is perfect, but more perfect than necessary, and therefore useless. Rubel comments on this urge toward perfect precision in the context of wargames, remarking, “...we could easily conclude that the knowledge produced by highly distilled games is more conditional and less predictive than that from simulations having greater fidelity. Such reasoning would force us to conduct nothing but elaborate and expensive games.”³¹

Examples of wargames used for training are not difficult to find. For example, one might hold a wargame for the purpose of exposing a collection of actors to an idea, finding, or concept

exogenously derived (e.g., doctrine) in such a way as to achieve buy-in for that idea. Robert Rubel describes this as a tacit purpose of the U.S. military's Title X wargame series, for example.³² Similarly, the purpose of a wargame may be less to teach individual actors how to respond in a given situation and more to socialize those actors with one another, to expose them to the objective realities of organizations, procedures, and personnel. Rubel offers an interesting example of wargames designed to illuminate homeland security and emergency management requirements following 9/11.³³

While focus remains on development of the participants, education is different from training in the context of wargames. While training seeks to inculcate the nominally correct response to given inputs, education is more a matter of inculcating the habits of mind essential to navigating situations of competition and strategic decision making. While in a training environment, the validity of the game is in some sense paramount, in this educational paradigm it is rather the actuality of the players that matters and the oppositions of their interests and wills. Strategy is fundamentally a matter of interaction, after all, "not the action of a living force upon a lifeless mass...but always the collision of two living forces"³⁴ and "in war, as in life generally, all part of the whole are interconnected and thus the effects produced, however small their cause, must influence all subsequent military operations."³⁵ Therefore, there is an internal paradox in the logic of strategy in which the *correct* answer becomes the *incorrect*...precisely because it is correct (and vice versa).³⁶ These are unfamiliar habits of mind, but they can be taught, and wargames are one method to teach them, offering students "opportunities to make tough choices, study their decision-making calculus, and appreciate the consequences."³⁷ Dr. James Lacey, a professor of strategic studies at the Marine Corps War College, offers a cogent description of the

value of wargames used thus. In teaching Thucydides' Peloponnesian War, he uses a commercial wargame to supplement the typical readings on the subject. The result?

As every team plotted their strategic "ends," students soon realized that neither side had the resources—"means"—to do everything they wanted. Strategic decisions quickly became a matter of tradeoffs, as the competitors struggled to find "ways" to secure sufficient "means" to achieve their objectives ("ends"). For the first time, students were able to examine the strategic options of the Peloponnesian War within the strictures that limited the actual participants in the struggle.³⁸

There is, perhaps, an additional value in the approach, and the particular games, used by Lacey in creating these strategic habits of mind in his students through wargames, and that is in the particular games chosen. These games are removed to a degree from the reality of the actual decisions—and especially from the particular ways and means—these students will one day manage. This mitigates the tendency toward the inculcation of what Clausewitz would proscribe as "a positive doctrine, a sort of manual for action"³⁹ and what Peter Berger and Thomas Luckman would characterize as reification of the model (or wargame):

Reification is the apprehension of human phenomena as if they were things, that is, in non-human or possibly supra-human terms. Another way of saying this is that reification is the apprehension of products of human activity as if they were something else than human products—such as the facts of nature, results of cosmic laws, or manifestations of divine will. Reification implies that man is capable of forgetting his own authorship of the human world, and further, that the dialectic between man, the producer, and his products is lost to consciousness. The reified world is, by definition, a dehumanized world. It is experienced by man as a strange facticity, an *opus alienum* over which he has no control rather than as the *opus proprium* of his own productive activity.⁴⁰

Reification, in other words, makes the model or wargame the object of study, making it a thing given rather than a thing created, and divorces the study of that model from the study of the world. Distancing games intended for strategic education (or for the study of history) from the realities of current ways and means can perhaps mitigate this tendency, instead fostering strategic habits of mind and a:

...capacity to analyze the constituent elements of war, to distinguish precisely what at first seems fused, to explain in full the properties of the means employed and to show their probable effects, to define clearly the nature of the ends in view, and to illuminate all phases of war in a thorough critical inquiry.⁴¹

This can, of course, be taken too far. As Peter Perla notes, citing Admiral Arleigh Burke, “In a wargame, real forces do not deploy, real weapons do not engage, and real people do not die. Wargames, like exercises, are only an imperfect image of real war, no matter whether they are the paper and cardboard images of the hobbyist or the sophisticated computer images of the professional.”⁴²

The third purpose of wargames rests on the premise that they do not stand on their own but rather form one element of what Peter Perla characterizes as the “cycle of research” involving the integration of wargames, exercises, and mathematical analyses to make sense of the reality of data, decisions, and actions.⁴³ A particularly important part in this process is played by wargames in the process of hypothesis generation, the creative elucidation of new theories for subsequent testing; some give this such primacy that it defines wargaming as “a formal experiment for the purposes of theory generation.”⁴⁴ The idea here is that induction takes the observation of particular characteristics and extrapolates to a supposition that these particular characteristics apply to universally to a class; importantly, however, induction does not supply explanatory or causal mechanisms. Deduction, on the other hand, assumes or accepts causal mechanisms and premises and proceeds from them; so, in a sense. In a sense, there is no new theoretical information created in either of these processes. Charles Pierce, a philosopher of science writing in the late eighteenth and early twentieth centuries proposed a third logical mechanism, abduction or “a method of reasoning in which one chooses the hypothesis which would, if true, best explain the relevant evidence. Abductive reasoning starts from accepted facts and infers to their most likely, or best, explanation.”⁴⁵ Brigadier General (ret) Huba Wass de

Czege describes this as a process that “starts when an inquirer considers a set of seemingly unrelated facts, armed with an intuition that they are somehow connected” and produces a hypothesis, a theory of causal logic, that connects them.⁴⁶ And, according to Pierce, “All the ideas of science come to it by way of Abduction.”⁴⁷

Wargames are operative in this sense due to two factors differentiating them from engineering problems and from the study of military history. In the first instance, war and warfare are weakly structured and characterized by what Robert Rubel, borrowing from John Hanely, calls structural indeterminacy, where “significant elements of the problem are so little known or understood” as to “require tools that can accommodate their considerable imprecision.”⁴⁸ Wargames can do this, so the argument goes, but the knowledge that results has neither the certainty of deduction nor is the method itself well-structured enough to warrant generalizing in the sense demanded by induction, since a wargame begins as a single instance. What it can do is to “indicate the possibilities of a projected warfare simulation and certain potential cause and effect linkages.”⁴⁹ This indicative knowledge, suggesting possibilities, is precisely the kind of information to which abduction is applied, drawing out and evaluating competing explanatory hypotheses and, as it were, inferring to the best explanation. This explanatory/causal hypothesis is then subject to test in Perla’s “cycle of research.” In the second instance, the study of military history, there are two critical gaps abductively filled by wargames. Clausewitz points out, that in the critical and historical analysis of war,

The deduction of effect from cause is often blocked by some insuperable extrinsic obstacle: the true causes may be quite unknown. Nowhere in life is this so common as in war, where the facts are seldom fully known and the underlying motives even less so. They may be intentionally concealed by those in command, or, if they happen to be transitory and accidental, history may not have recorded them at all. That is why the critical narrative must usually go hand in hand with historical research. Even so, the disparity between cause and effect may be such that the critic is not justified in considering the effects as the inevitable results of

known causes. This is bound to produce gaps—historical results that yield no useful lessons.⁵⁰

Historical analysis, of itself, will leave gaps that cannot be filled from the historical record. A wargame can offer direct and recordable insight into the decision-making processes and their interaction with known information, providing the necessary data to create a creative, abductive leap to the generation of a hypothesis regarding the cause and effect in question. Moreover, there are cases in which “[t]he critic, then, having analyzed everything within the range of human calculation and belief, will let the outcome speak for that part whose deep, mysterious operation is never visible.”⁵¹ In history, there is, in a sense, a fixed outcome; we can study only that which happened, and we may privilege that outcome with an inevitability that masks the possibilities for cause and effects logics. Wargames can overcome this constraint of history, considering the possibilities of different outcomes in replaying simulations of an event and providing insight into the alternative outcomes that might have arisen and the causal paths that might have led to them.⁵² This, again, provides fodder for the abductive leap to theory and hypothesis regarding (potentially) testable causal mechanisms.⁵³

With respect to the final area of wargame utility, there may be no more widely accepted view than that the use of wargames as scientific data, to use in the confirmation and/or falsification of hypotheses, is at least problematic and at worst impossible. For example, Robert Rubel, former professor at the Naval War College’s Center for Naval Warfare Studies, suggests that analysis of wargames as single data points (searching for commonalities, correlations, etc.) is “intellectually unsupportable” on basis that games not specifically designed for this purpose (e.g., reproducing the same game again and again) will differ on substantive grounds that prevent it and that the nature of games as simulations of reality in which players are likely to do things they would not do in a real conflict.⁵⁴ These concerns, while legitimate, do not prevent or event

seriously mitigate the careful use of games in accumulating evidence for or against a theory or hypothesis. If this weren't the case, then entire fields of inquiry would be rendered invalid. For example, with respect to the first objection, case study methods relying on case studies across time, circumstance, culture, participants, etc., a cornerstone of research in social science, would not be possible. Yet, there are well-established methods for both developing and testing hypotheses from case studies.⁵⁵ And the second objection would similarly render problematic methods in social and behavioral sciences ranging from the experiments to game theory. And yet we gain insight from behavioral psychology⁵⁶ or game theory.⁵⁷

Why this insistence on problematizing wargames as a source of data to test hypotheses? Perhaps this misconception derives from an oddity of training and education and in the statistical applications of hypothesis testing. This is, after all, one of the clearest and most explicit cases in which a theory is subject to quantitative assessment and potential falsification. The approach to hypothesis testing most commonly taught to frame a position on the value of a statistical parameter, such as a mean value, and then—since observed or experimental data is likely to vary in some probabilistic way—rather than confirming the truth of the position to ask whether the data collected differs enough from the hypothesized position that the result is statistically unlikely.⁵⁸ The language here is carefully chosen; there is no mathematical or engineering proof provided of either the truth or falsehood in the proposition, and this matters enormously. Rather, what results from the test is only evidence for or against a proposition. And even in the laboratory, physical, and social sciences, replete with opportunities for peer review and possibilities for reproducibility, each instance of confirmation or disconfirmation remains strictly evidentiary...and mistakes are made for all the reasons raised in objection to wargames as data.⁵⁹ This is not the only view of hypothesis testing, however; a proponent for a more nuanced view of

a test of hypothesis as evidence was the statistical luminary, Ronald Fisher. In his formulation, fixed thresholds for statistical significance so common in most approaches to Neyman-Pearson models of hypothesis testing, Fisher advocated the reporting of a statistical measure of the strength of the evidence for or against the proposition in the experimental data, that should be combined with other evidence to advance understanding and draw conclusions.⁶⁰

If not based in a naïve view of statistical inference, perhaps the complaint with wargames as suitable means to test, perhaps there is an implicitly naïve view of the process of science and falsification in play. If trained in laboratory sciences, mathematics, engineering, operations research, etc., perhaps the standard of evidence assumed necessary is higher than that taken in other, eminently scientific fields, and perhaps the community of wargamers would benefit from an influx of political scientists and historians into their analytic ranks.⁶¹ Or perhaps there is an operative view based on naïve empirical falsification incompatible with the more nuanced views of its progenitors. Or perhaps it finds root in a misunderstanding of the differences between so-called normal science and anomaly. The emergence of any single anomaly, that might be naïvely viewed as a warrant for falsification of a theory, does not necessitate the abandonment of a scientific theory or paradigm; the accumulated weight of anomaly does so.⁶² The bottom line is that all information should be considered as available evidence, and any notion of hypothesis testing or falsification that rejects the possibility of wargames as providing evidence in this regard is hopelessly naïve.

Conclusion

Wargames have a long history of utility in training and educating strategists and decision-makers. They have been and can be used to train individuals to execute school-book solutions to appropriately clear decision problems in appropriately determinate environments, and they can be used to inculcate habits of mind suited to strategic decision-making in situations of greater indeterminacy. In fact, a cogent argument can be made that wargames are uniquely suited to highly indeterminate problems—problems like war and warfare, for example—and for illuminating these problems, suggesting theoretical models for cause and effect and hypotheses for test. But the very indeterminacy of these situations leads to an interesting observation, that in these situations “the answers to strategic choices cannot be ‘discovered’ because they are not self-evident; there are always unknowable and uncontrollable factors at work.”⁶³ But this indeterminacy, and the indeterminacy of the tools illuminating the strategic decision-making experiments that are wargames do not prevent the results of these games in evaluating cause and effect hypotheses about strategic choices in war and warfare. They may suggest a conditionality and caution in the exercise of this evidence in confirming or falsifying claims, but this is not different from experiment and evidence in any other scientific or logical endeavor.

Notes

¹ Martin Van Creveld, *Wargames: From Gladiators to Gigabytes* (Cambridge, UK: Cambridge University Press, 2013), 141.

² Peter P. Perla, *The Art of Wargaming* (Annapolis, MD: Naval Institute Press, 1990), 17.

³ Ibid., 40 and “Wehrschach,” BoardGameGeeks, <https://boardgamegeek.com/boardgame/27594/wehrschach>

⁴ Quoted in Perla, *Art of Wargaming*, 25-26.

⁵ Ibid., 73.

⁶ Mark Herman, Mark Frost, and Robert Kurz, *Wargaming for Leaders: Strategic Decision Making from the Battlefield to the Boardroom* (New York, NY: McGraw Hill, 2009), 1-3.

⁷ Robert O. Work and Paul Selva, “Revitalizing Wargaming is Necessary to be Prepared for Future Wars,” *War on the Rocks*, 8 December 2015. <http://warontherocks.com/2015/12/revitalizing-wargaming-is-necessary-to-be-prepared-for-future-wars>

⁸ An interesting recent example is the recent series of RAND wargames exploring the problem of deterrence and defense in the Baltics. While establishing a causal link between the RAND wargames, which concluded a multi-brigade presence of North Atlantic Treaty Organization troops in the Baltic might be enough—or, indeed, necessary—to affect Russian strategic calculus sufficiently to deter an attack on the Baltic states. David A. Shlapak and Michael W. Johnson, *Reinforcing Deterrence on NATO's Eastern Flank: Wargaming the Defense of the Baltics. RAND Research Report*, RR-1253-A. Santa Monica, CA: RAND Corporation, 2016; and Karl Muellerl, David A. Shlapak, Michael W. Johnson, and David Ochmanek, “In Defense of a Wargame: Bolstering Deterrence on NATO's Eastern Flank,” *War on the Rocks*, 14 June 2016. <http://warontherocks.com/2016/06/in-defense-of-a-wargame-bolstering-deterrence-on-natos-eastern-flank>

⁹ Confucius, *The Analects* 13.3, trans. James Legge, The Chinese Text Project, <http://ctext.org/analects/zi-lu> (accessed 21 December 2016).

¹⁰ Edward Bruce Hamly, *The Operations of War: Explained and Illustrated* (London, UK: Blackwood and Sons, 1866), 3.

¹¹ Ibid., 4.

¹² Albert Einstein, “On the Method of Theoretical Physics,” *Philosophy of Science* 1, no. 2 (April 1934), 165.

¹³ Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976), 75..

¹⁴ Ibid., 87.

¹⁵ *The American Heritage Dictionary of the English Language*, 5th ed., s.v., “game.”

¹⁶ Van Creveld, *Wargames: From Gladiators to Gigabytes*, 4.

¹⁷ Ibid., 3, 4-5.

¹⁸ The definition developed by Van Creveld does prove useful in developing an interesting and wide-ranging topic for a book, however, and each of the referenced topics, among others, is covered in his *Wargames: From Gladiators to Gigabytes*. Of interest, the mock combats or nothing fights characterized by Van Creveld as a wargame fit into a form of conflict included by John Keegan in his famous dissent from Clausewitz. He wrote, for example, that “war embraces more than politics: that it is always an expression of culture, often a determinant of cultural forms, in some societies the culture itself.” He goes on to expand on various expression of war in culture, including the highly ritualized forms practiced by some peoples. See John Keegan, *A History of Warfare* (New York, NY: Vintage Books, 1994), 12, 24-46.

¹⁹ Perla, *Art of Wargaming*, 164. Perla later describes a wargame as “an experiment in human interaction,” suggesting that “[w]ithout human players here may be a model, but there is no game.” (274) This raises some interesting questions about artificial intelligence and the possibility of creativity, abduction, and the embrace of

paradoxical logic of adversarial strategy in non-human play. An interesting look at some relatively recent advances in this area—anticipation of adversary strategies and the embrace of paradoxical logic—is compiled in Alexander Kott and William M. McEneaney, eds., *Adversarial Reasoning: Computational Approaches to Reading the Opponent's Mind* (New York, NY: Chapman and Hall, 2007).

²⁰ See, for example, Philip Sabin, *Simulating War: Studying Conflict through Simulation Games* (New York, NY: Bloomsbury Academic, 2015), 3 or Robert C. Rubel, “The Epistemology of War Gaming,” *Naval War College Review* 59, no. 2 (Spring 2006), 109.

²¹ H.G. Wells, *Little Wars* (New York, NY: Da Capo Press, 1977), 97.

²² As interesting as this idea is, it's somewhat outside the interest of wargames as played instrumentally by the military.

²³ Perla, *Art of Wargaming*, 4. Jason Trew makes a similar argument regarding the utility of play in strategy. See Jason Trew, “Can Strategy be Playful?” *PAXSims*, 12 November 2016, <https://paxsims.wordpress.com/2016/11/12/trew-can-strategy-be-playful>

²⁴ Robert C. Rubel, “The Epistemology of War Gaming,” *Naval War College Review* 59, no. 2 (Spring 2006): 109.

²⁵ RAND, “Wargaming.” <http://www.rand.org/topics/wargaming.html>

²⁶ *The American Heritage Dictionary of the English Language*, 5th ed., s.v., “train.”

²⁷ This is an assertion borne out in other fields. For example, see Martin Boeker, Peter Andel, Werner Vach, and Alexander Frankenschmidt, “Game-Based E-Learning Is More Effective than a Conventional Instructional Method: A Randomized Controlled Trial with Third-Year Medical Students,” *PLOS ONE* 8, no. 12 (December 2013): e82328. <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0082328>

²⁸ Stewart Schlesinger et al., “Terminology for Model Credibility,” *Simulation* 32, no. 3 (1979), 104.

²⁹ George E.P. Box, “Science and Statistics,” *Journal of the American Statistical Association* 71, no. 356 (December 1976): 792. This echoes a similar sentiment from the similarly influential Albert Einstein, who wrote, “It can scarcely be denied that the supreme goal of all theory is to make the irreducible basic elements as simple and as few as possible without having to surrender the adequate representation of a single datum of experience.” See Albert Einstein, “On the Method of Theoretical Physics,” *Philosophy of Science* 1, no. 2 (April 1934): 165. The notion that “essentially all models are wrong, but some are useful” is a popular one, repeated often by Box. It is, however, a problematic notion if misapplied or misunderstood. For a discussion of these dangers, see Eric M. Murphy, “Right, Wrong, & Relevant,” *The Strategy Bridge*, 17 September 2015. <http://thestrategybridge.org/the-bridge/2015/9/20/right-wrong-relevant-how-to-be-right-in-the-ways-that-matter>

³⁰ Jorge Luis Borges, “On Exactitude in Science,” in *Collected Fictions*, trans. Andrew Hurley (New York, NY: Penguin Classics): 325.

³¹ Rubel, “Epistemology of Wargames,” 114.

³² This is reminiscent of Brigadier General (ret) Huba Wass de Czege's characterization of collaborative design. While he is not speaking explicitly about wargames, the mechanics and objectives are not dissimilar when he suggests, “The logic and method of design...is first and foremost a collective research methodology for considering the best available information to make sense of what is known in order to construct an explicit and shared hypothesis.” Huba Wass de Czege, “The Logic and Method of Collaborative Design,” *Small Wars Journal*, 12 May 2010. <http://smallwarsjournal.com/jrnl/art/the-logic-and-method-of-collaborative-design>

³³ Rubel., 112-113.

³⁴ Carl von Clausewitz, *On War*. Ed. and trans Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976), 77.

³⁵ *Ibid.*, 158. This is precisely the notion of interdependence and nonlinearity that leads to sensitivities to initial conditions and the difficulties of prediction in strategic environments or, indeed, any environment characterized by recursive interdependence. For discussions of these phenomena in Clausewitz, see Alan D. Beyerchen, “Clausewitz, Nonlinearity and the Unpredictability of War,” *International Security* 17, no. 3 (Winter 1992-1993): 59-90. For a discussion of these phenomena more generally, see Eric M. Murphy, *Complex Adaptive Systems and the*

Development of Force Structures for the United States Air Force (Maxwell AFB, AL: Air University Press, 2014), 1-30.

³⁶ Edward N. Luttwak, *Strategy: The Logic of War and Peace* (Cambridge, MA: Belknap Press, 2001), 3.

³⁷ Jeff Wong, "Wargaming in Professional Military Education: A Student's Perspective," *The Strategy Bridge*, 14 July 2016. <http://thestrategybridge.org/the-bridge/2016/7/14/wargaming-in-professional-military-education-a-students-perspective>

³⁸ James Lacey, "Wargaming in the Classroom: An Odyssey," *War on the Rocks*, 19 April 2016. <http://warontherocks.com/2016/04/wargaming-in-the-classroom-an-odyssey>

³⁹ Clausewitz, *On War*, 141.

⁴⁰ Peter L. Berger and Thomas Luckmann, *The Social Construction of Reality: A Treatise in the Sociology of Knowledge* (New York, NY: Anchor Books, 1967), 89.

⁴¹ Clausewitz, *On War*, 141.

⁴² Perla, *Art of Wargaming*, 250.

⁴³ *Ibid.*, 287-288.

⁴⁴ Jon Compton, "Analytical Wargaming," Unpublished working paper, Office of the Secretary of Defense, Cost Analysis and Program Evaluation, 2016. This assertion rests in large measure on an assessment that wargames are unsuitable for the process of testing hypotheses. More will be said on this in a moment.

⁴⁵ E.J. Capaldi and Robert W. Proctor, "Are Theories to Be Evaluated in Isolation or Relative to Alternatives? An Abductive View," *The American Journal of Psychology* 121, no. 4 (Winter 2008): 620-621.

⁴⁶ Huba Wass de Czege, "Thinking and Acting Like and Early Explorer: Operational Art is Not a Level of War," *Small Wars Journal*, 14 Mar 2011. <http://smallwarsjournal.com/blog/journal/docs-temp/710-deczege.pdf>

⁴⁷ Charles S. Pierce, *Collected Papers*, vol. 5, *Pragmatism and Pragmaticism* (Cambridge, MA: Harvard University Press, 1960), 90.

⁴⁸ Rubel, "Epistemology of War Gaming," 111. He borrows from John T. Hanley, "On Wargaming" (PhD diss, University of Michigan, 1991), 13-25.

⁴⁹ Rubel, *Epistemology of War Gaming*, 112.

⁵⁰ Clausewitz, *On War*, 157.

⁵¹ *Ibid.*, 167.

⁵² There is another potential value in this creation of alternate histories as an antidote to what Nassim Nicholas Taleb calls the narrative fallacy, the "need to fit a story or pattern to a series of connected or disconnected facts." Nassim Nicholas Taleb, *The Black Swan: The Impact of the Highly Improbable* (New York, NY: Random House, 2007), 309. In the field of history, a similar characterization has been made by Hayden White, who wrote, "A discipline that produces narrative accounts of its subject matter as an end in itself seems methodologically unsound; one that investigates its data in the interest of telling a story about them appears theoretically deficient." He concludes, "The fact that narrative is the mode of discourse common to both 'historical' and 'non-historical' cultures and that it predominates in both mythic and fictional discourse makes it suspect as a manner of speaking about 'real' events." Hayden White, "The Question of Narrative in Contemporary Historical Theory," *History and Theory* 23, no. 1 (February 1984), 1-33. The creation of alternate histories in the body of wargames implicitly necessitates alternate narratives of cause and effect, and alternate narratives break the neat fit of a series of connected or disconnected facts into a single necessary story.

⁵³ How can theories and hypotheses be developed from wargames? The notion of abduction as a creative leap suggests there is no fixed recipe for their development, a conclusion echoed in the social sciences. Milton Friedman, who also appeals to the creative aspect of the problem precluding a fixed recipe: the construction of hypothesis "is a creative act of inspiration, intuition, invention...the process must be discussed in psychological, not logical, categories; studied in autobiographies and biographies, not treatises on scientific method; and promoted by maxim and example, not syllogism or theorem." Milton Friedman, *Essays on Positive Economics* (Chicago, IL: University

of Chicago Press, 1953), 43. Stephen Van Evera is nevertheless able to offer a number of mechanisms that might aid in theory-making, several of which apply to a body of wargames considered as cases, and several that apply to individual wargames as single cases. See Stephen Van Evera, *Guide to Methods for Students of Political Science* (Ithaca, NY: Cornell University Press, 1997), 21-27.

⁵⁴ Rubel, "Epistemology of War Gaming," 123.

⁵⁵ Van Evera, *Methods for Students of Political Science*, 49-88.

⁵⁶ See, for example, Dan Ariely, *Predictably Irrational: The Hidden Forces That Shape Our Decisions* (New York, NY: Harper Perennial, 2008).

⁵⁷ Consider, for example, the utility of game theory in explicating a macro phenomenon such as the tragedy of the commons or See. For example, Garret Hardin, "The Tragedy of the Commons," *Science* 162, no. 3859 (13 December 1968): 1243-1248; Mancur Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups* (Cambridge, MA: Harvard University Press, 1971), or Joanne Gowa, "Anarchy, Egoism, and Third Images: The Evolution of Cooperation in International Relations," *International Organization* 40, no. 1 (Winter 1986): 167-186.

⁵⁸ This framing is commonly attributed to Karl Pearson and Jerzy Neyman. See E.L. Lehman, "The Fisher, Neyman-Pearson Theories of Testing Hypotheses: One Theory or Two?" *Journal of the American Statistical Association* 88, no. 424 (December 1993): 1242-1249.

⁵⁹ For wide-ranging examinations of how these issues of confirmation and disconfirmation are socially influenced and lead to David H. Freedman *Wrong: Why Experts Keep Failing Us—And How to Know When Not to Trust Them* (New York, NY: Little, Brown & Company, 2010) and Kathryn Schulz, *Being Wrong: Adventures in the Margin of Error* (New York, NY: ECCO, 2010).

⁶⁰ Lehman, "The Fisher, Neyman-Pearson Theories," 1242-1249. Of interest, the relationship between Jerzy Neyman and Karl Pearson on the one hand and Ronald Fisher on the other, based on the philosophical differences evident in their respective approaches to hypothesis testing, was legendary for its acrimony. See Herbert I. Weisberg, *Willful Ignorance: The Mismeasure of Uncertainty* (New York, NY: John Wiley and Sons, 2014), 302-305.

⁶¹ The difference between these fields of endeavor is covered in great depth in John Lewis Gaddis, *The Landscape of History: How Historians Map the Past* (Oxford, UK: Oxford University Press, 2002).

⁶² For an in-depth discussion of these ideas, see Imre Lakatos, "Falsification and the Methodology of Scientific Research Programmes," in *Criticism and the Growth of Knowledge: Proceedings of the International Colloquium in the Philosophy of Science, London, 1965, Vol. 4. 1st ed.*, ed. Imre Lakatos and Alan Musgrave (Cambridge, UK: Cambridge University Press, 1970), 91-196.

⁶³ Huba Wass de Czege, "Operational Art: Continually Making Two kinds of Choices in Harmony While Learning and Adapting" *ARMY Magazine* 61, no. 9 (September 2011): 50.

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